MAP GQ-1627

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

GEOLOGIC MAP OF THE PINEWOOD LAKE QUADRANGLE, BOULDER AND LARIMER COUNTIES, COLORADO

By Raymundo Punongbayan, James C. Cole, William A. Braddock, and Roger B. Colton

GEOLOGIC QUADRANGLE MAP
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DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

GEOLOGIC QUADRANGLE MAP
PINEWOOD LAKE QUADRANGLE, COLORADO
GQ-1627

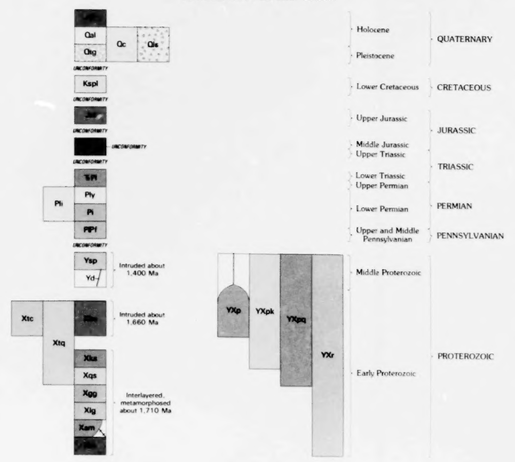
Base from U.S. Geological Survey, 1962
Photorevised as of 1978
10,000-foot grid based on Colorado coordinate system, north zone
1000-meter Universal Transverse Mercator grid ticks, zone 13, shown in blue

SCALE 1:24 000
1 MILE
1 KILOMETER
CONTOUR INTERVAL 40 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

COLORADO
QUADRANGLE LOCATION

See index to geologic mapping

CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

[All radiometric ages quoted here have been recalculated using the IUGS decay constants (Steiger and Jager, 1977)]

Manmade fill (Holocene)—Only large, rock and earth fills are shown

Qal **Alluvium (Holocene)**—Unconsolidated deposits of silt, sand, and gravel that underlie flood plains of major streams and form terraces up to 40 ft (12 m) above nearby flood plains

Qc **Colluvium and alluvium, undivided (Quaternary)**—Poorly sorted, unconsolidated silt, sand, clay, gravel, and boulders. Deposits were formed by sheetwash, by debris flows, and by concentrated surface flow in intermittent streams. Commonly mixed with talus

Qls **Landslide deposits (Quaternary)**—Slumps and earthflows composed of clay, silt, sand, and boulders as much as several meters in diameter. Large rock falls. Also includes block-glide landslides which have poorly defined boundaries and internal structures

Qtg **Gravel deposits (Pleistocene)**—Reddish-brown or white, poorly sorted, and poorly to well stratified. Clasts mostly derived from Precambrian rocks

Dakota Group (Lower Cretaceous)—Subdivisions of the Dakota are those defined by Waage (1955)

Kspl **Plainview Sandstone Member of the South Platte Formation and the Lytle Formation, undivided**—Plainview Sandstone Member: Gray to light-brown, thinly bedded, fine-grained carbonaceous sandstone. Lytle Formation: Gray to light-brown, coarse-grained to conglomeratic sandstone and blocky-weathering, varicolored, noncarbonaceous mudstone. Occurs in southeast corner of map where only lower part of Lytle crops out

Jm **Morrison Formation (Upper Jurassic)**—Green, red, yellow, and white, blocky-weathering claystone and siltstone; interbedded gray micrite; and gray, fine- to medium-grained sandstone; about 310 ft (94 m) thick

Js **Sundance Formation (Middle Jurassic) and Jelm Formation (Upper Triassic), undivided**—In map area Sundance and Jelm Formations (Pipiringos and O'Sullivan, 1976) have a combined thickness of about 98 ft (30 m). The Pine Butte Member of the Sundance, which consists of about 5 ft (1.5 m) of massive to flat-bedded, fine-grained, gray to white sandstone, conformably overlies the Canyon Springs Sandstone Member of the Sundance. The Canyon Springs consists of about 19 ft (5.8 m) of pink, orange-pink, or reddish-brown, fine- to medium-grained, crossbedded calcareous sandstone. It unconformably overlies the Red Draw Member of the Jelm Formation. The unconformity is marked by the presence of conspicuous chert pebbles. The Red Draw Member consists of about 74 ft (22 m) of orange-pink or reddish-brown, fine-grained, crossbedded calcareous sandstone, which unconformably overlies the Lykins Formation

TRPf **Lykins Formation (Lower Triassic and Upper Permian)**—Dominantly red and reddish-brown siltstone and fine-grained sandstone containing several thin carbonate beds. The total thickness of the formation is about 505 ft (154 m). Subdivisions defined by Broin (1957) cannot be mapped because of poor exposure

Ply **Lyons Sandstone (Lower Permian)**—Orange to pink to pinkish-gray, fine- to medium-grained, well-sorted quartz sandstone. Commonly well cemented with quartz cement. Characterized by large-scale dune crossbedding. About 50 ft (15 m) thick

Pi **Ingleside Formation (Lower Permian)**—Reddish-pink, fine-grained quartz sandstone. Commonly well cemented with quartz. Characterized by planar beds a few inches to a few feet thick, which are internally crossbedded. Thickness about 200 ft (61 m)

Pli **Lyons Sandstone and Ingleside Formation, undivided (Lower Permian)**—Shown only on cross sections

PIPf **Fountain Formation (Lower Permian and Upper and Middle Pennsylvanian)**—Reddish-brown to purplish-gray arkosic conglomerate, medium- to coarse-grained feldspathic sandstone, and dark-reddish-brown siltstone and shale; minor thin limestone beds; about 1,100 ft (335 m) thick

INTRUSIVE IGNEOUS ROCKS (MIDDLE PROTEROZOIC)

Ysp **Silver Plume Granite**—Equigranular to porphyritic granite containing characteristic subhedral microcline phenocrysts. Occurs as generally discordant bodies ranging in size from small plugs and dikes to bodies of batholithic dimensions extending beyond the limits of the quadrangle. Composed of microcline, plagioclase, quartz, biotite, and muscovite; commonly has aligned phenocrysts of microcline. Whole rock Rb-Sr age is 1,420±30 Ma (Peterman and others, 1968, p. 2291)

Yd **Mafic dikes**—Black to dark or light-gray, fine- to medium-grained rocks of basaltic or andesitic composition, which form a north- to northwest-trending dike swarm throughout much of the northern Front Range. Plagioclase forms phenocrysts in most dikes. The mineralogy and texture vary both regionally and locally. The variations are due to primary magmatic factors, such as bulk composition and rate of cooling, and are also due to metamorphism, which has affected the dikes to varying degrees.

Because of crosscutting relations at various places in the northern Front Range, the dike swarm is believed to be intermediate in age between the Silver Plume Granite and Sherman Granite.

Three dikes of fine-grained biotite diorite occur in the northeast corner of the quadrangle, and one dike of fine-grained hornblende-biotite quartz diorite occurs in sec. 2 at the southern boundary of the quadrangle

YXp **Pegmatite (Middle and Early Proterozoic)**—Coarse-grained to very coarse grained. Both Middle and Early Proterozoic pegmatites occur but cannot be unequivocally separated by field examination. Many pegmatites are probably related to emplacement of the Silver Plume Granite. Conformable pegmatites are probably mostly Early Proterozoic age and commonly form phacoliths; they may be related to emplacement of the Boulder Creek Granodiorite or the result of migmatization

YXpk **Pegmatite and knotted mica schist (Middle and Early Proterozoic)**—Generally conformable interlayered pegmatite and schist. Contacts are gradational into Xks

YXqg **Pegmatite and quartzofeldspathic mica schist (Middle and Early Proterozoic)**—Generally conformable interlayered pegmatite and schist. Contacts are gradational into Xks

INTRUSIVE IGNEOUS ROCKS (EARLY PROTEROZOIC)

Xtc **Trondhjemite of Thompson Canyon**—Light-tan to gray, fine-grained, porphyritic to medium-grained igneous rock composed of sodic plagioclase, quartz, biotite, and microcline

Xtq **Trondhjemite and quartzofeldspathic mica schist**—Trondhjemite forms many irregular pods and sills separated by mica schist

Xbc **Boulder Creek Granodiorite**—Medium- to coarse-grained, gray, gneissic granodiorite, which contains biotite-rich schlieren. Occurs as small bodies included in the Silver Plume Granite in the southern part of the quadrangle

METASEDIMENTARY AND METAVOLCANIC ROCKS (EARLY PROTEROZOIC)

Schist units (**Xks**, **Xqs**), and marble (**Xm**) are metasedimentary rocks; amphibolite (**Xam**) and granitic gneiss (**Xgg**) are probably metavolcanic. The schists vary in metamorphic grade and mineralogy as shown by the metamorphic zone boundaries (see explanation of "Boundary of metamorphic zone in pelitic rocks"). Pelitic rocks south of the Moose Mountain shear zone are migmatitic and are metamorphosed to a higher grade than the **M** metamorphic zone boundary. Whole rock Rb-Sr age of the time of regional metamorphism is 1,713±30 Ma (Peterman and others, 1968). The age of deposition cannot be much older, because Sm-Nd isotopic analyses are consistent with a model age of 1,800 Ma for the formation of continental crust in Colorado (DePaolo, 1981)

Xbs **Knotted mica schist**—Biotite schist containing clots of metamorphic minerals that give a lumpy or knotted appearance to exposures. Mineralogic composition varies and is indicated by the metamorphic zone boundaries shown on map

Xqs **Quartzofeldspathic mica schist**—Mica schist and phyllite interbedded with quartzofeldspathic metasandstone. Mineralogic composition varies and is indicated by the metamorphic zone boundaries shown on map

Xgg **Granitic gneiss**—Medium-grained gneiss composed of abundant microcline, quartz, and plagioclase. Biotite and magnetite form less than 5 percent of the rock

Xig **Leucocratic gneiss and pegmatite**—Aplitic to pegmatitic, gray to tan gneiss composed of quartz, microcline, and plagioclase

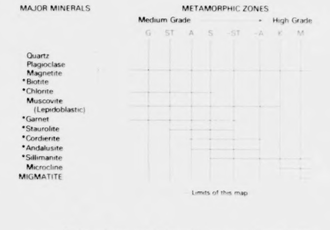
Xam **Amphibolite and hornblende gneiss**—Weakly to strongly layered hornblende-plagioclase gneiss locally interlayered with massive amphibolite. Contains thin layers and pods of white to light-green calc-silicate gneiss. Also contains interlayers of banded plagioclase-biotite gneiss

Xm **Marble**—Gray, medium-grained, layered marble. Some layers contain abundant quartz, microcline, and amphibole; some layers are mostly calcite. Only one small occurrence is known in the SE1/4 sec. 24, T. 4 N., R. 71 W.

YXr **Proterozoic rocks, undivided (Middle and Early Proterozoic)**—Shown only on cross sections

Boundary of metamorphic zone in pelitic rocks—Approximately located; dashed where projected through younger igneous rocks, queried where position is uncertain by as much as 2,000 ft (600 m). Boundaries are not located accurately enough to determine their offset across faults. Horizontal lines in the following diagram show major minerals that may be present in each zone in pelitic rocks of units **Xks** and **Xqs**. Dashed terminations of horizontal lines indicate uncertainty of limits. Asterisks (*) indicate minerals that commonly form porphyroblasts in rocks of lower grade than the **~A** boundary. sillimanite also forms knots in rocks of higher grade than the **S** boundary. In the prograde direction, the metamorphic zone boundaries are as follows: **G**, first occurrence of garnet; **ST**, first occurrence of staurolite; **A**, first occurrence of andalusite; **S**, first occurrence of sillimanite; **~ST**, last occurrence of staurolite; **~A**, last occurrence of andalusite; **K**, first occurrence of microcline and last occurrence of lepidoblastic muscovite; **M**, first occurrence of migmatite. The **M** metamorphic zone boundary occurs in the northeast part of the Panorama Peak quadrangle about 1,500 m west of the boundary of this quadrangle

MAJOR MINERALS



Contact—Approximately located. Contacts of Pennsylvanian through Cretaceous formations are solid where exposed, dashed where unexposed, dotted where concealed by younger units

Fault or fracture zone—Showing dip where known. Dashed where approximately located, dotted where concealed. R, apparent upthrown side of reverse fault

Shear zone—Boundaries are very gradational; the intensity of shearing within the zone is very inhomogeneous. Shear-zone rocks are protomylonite with thin layers of mylonite

Linear topographic feature—Recognizable on aerial photographs. No direct field evidence. May be fault or well-developed joints

Quartz-epidote vein

Folds—Showing plunge and approximate trace of axial surface; and bearing and plunge of hinge lines where known. Dashed where inferred, dotted where concealed. Form of folds shown by following symbols:

Anticline
Antiform
Syncline
Synform

Neutral fold—Showing curvature of layers in hinge (a neutral fold has no crest or trough lines)

Strike and dip of beds in sedimentary rocks
Inclined
Vertical

Strike and dip of foliations—May be combined with lineation symbols. Approximate orientation shown by symbol without dip value. Foliation within inclusions of metamorphic rock surrounded by igneous rock or pegmatite is indicated by double strike line

Overturned relict bedding—Known from observed sedimentary structures

Schistosity, relict bedding or compositional layering where parallel to schistosity, and metamorphic layering in intrusive igneous rocks
Inclined

Inclined—Showing continuous variation in strike and dip

Vertical

Crenulations cleavage—Number indicates fold episode in which cleavage was formed if known
Inclined

Vertical

Primary flow foliation in intrusive igneous rocks
Inclined

Vertical

Strike of foliation—Dip direction unknown

Mylonitic foliation
Inclined

Vertical

Bearing and plunge of lineations—May be combined with foliation symbols

Hinge lines of minor folds
Antiform

Fold—Showing map view

Small folds, crenulations, boudinage, or aligned minerals

Mylonitic streaking lineation

Quarry or prospect pit

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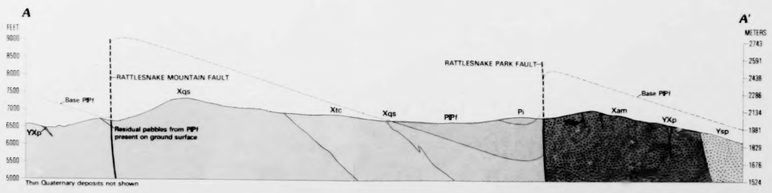
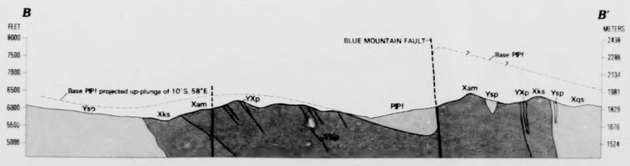
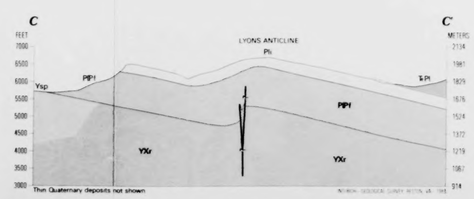
INDEX TO GEOLOGIC MAPPING

INDEX MAP SHOWING PUBLISHED 1:24,000-SCALE GEOLOGIC MAPS, NORTHEAST FRONT RANGE, COLORADO







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1989

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GEOLOGIC MAP SYMBOLS

COMMONLY USED ON MAPS OF THE UNITED STATES GEOLOGICAL SURVEY

(Special symbols are shown in explanation)

Contact – Dashed where approximately located; short dashed where inferred; dotted where concealed

Contact – Showing dip; well exposed at triangle

Fault – Dashed where approximately located; short dashed where inferred; dotted where concealed

Fault, showing dip – Ball and bar on downthrown side

Normal fault – Hachured on downthrown side

Fault – Showing relative horizontal movement

Thrust fault – Sawteeth on upper plate

Anticline – Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric anticline – Short arrow indicates steeper limb

Overturned anticline – Showing direction of dip of limbs

Syncline – Showing direction of plunge; dashed where approximately located; dotted where concealed

Asymmetric syncline – Short arrow indicates steeper limb

Overturned syncline – Showing direction of dip of limbs

Monocline – Showing direction of plunge of axis

Minor anticline – Showing plunge of axis

Minor syncline – Showing plunge of axis

Strike and dip of beds – Ball indicates top of beds known from sedimentary structures

Inclined ⊕ Horizontal

Vertical Overturned

Strike and dip of foliation

Inclined Vertical Horizontal

Strike and dip of cleavage

Inclined Vertical Horizontal

Bearing and plunge of lineation

Inclined Vertical Horizontal

Strike and dip of joints

Inclined Vertical Horizontal

Note: planar symbols (strike and dip of beds, foliation or schistosity, and cleavage) may be combined with linear symbols to record data observed at same locality by superimposed symbols at point of observation. Coexisting planar symbols are shown intersecting at point of observation.

Shafts

Vertical Inclined

Adit, tunnel, or slope

Accessible Inaccessible

Prospect

Quarry

Active Abandoned

Gravel pit

Active Abandoned

Oil well

Drilling Shut-in Dry hole abandoned

Gas Show of gas

Oil Show of oil

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